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10/050,570	01/18/2002	Kuniaki Yagi	Q68148	7078

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EXAMINER
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SONG, MATTHEW J

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 09/22/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

10/050,570

Applicant(s)

YAGI ET AL.

Examiner

Matthew J Song

Art Unit

1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 11 July 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-5, 10 and 11 is/are pending in the application.
- 4a) Of the above claim(s) 10 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-5 and 11 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

### Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

### Attachment(s)

- ☐ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_.
- ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_.
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Other: \_\_\_\_\_.

Art Unit: 1765

## **DETAILED ACTION**

### ***Election/Restrictions***

1. Pending claim 10 is directed to an invention that is distinct from the elected invention for the following reasons: Claim 10 is drawn to a product claim, which is restrictable for the same reasons Group II, claims 6-7 were restricted in paper 6. As a result, Claim 10 is considered to belong to non-elected group II and is presently withdrawn from consideration.

### ***Claim Objections***

2. The numbering of claims is not in accordance with 37 CFR 1.126 which requires the original numbering of the claims to be preserved throughout the prosecution. When claims are canceled, the remaining claims must not be renumbered. When new claims are presented, they must be numbered consecutively beginning with the number next following the highest numbered claims previously presented (whether entered or not).

Misnumbered claim 10 been renumbered 11.

### ***Claim Rejections - 35 USC § 112***

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims 1-5 and 10-11 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter, which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed

Art Unit: 1765

invention. Claim 1 recites, "heating the substrate under existence of a raw material containing C or Si, or C and Si to induce surface chemical reaction between said raw material and Si or C contained in the substrate, thereby forming the thin single crystal film" in lines 5-7. The instant specification does not provide support for the inducing surface chemical reaction between the raw material and the substrate. The instant specification merely teaches raw material gas is reacted in the vapor phase or on the substrate surface, note pg 13, lines 1-6. The instant specification does not explicitly teach the Si or C contained the substrate is reacted with the raw material. Applicant alleges page 11, lines 1-17 support this limitation, but a surface chemical reaction is not explicitly taught.

***Claim Rejections - 35 USC § 103***

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Art Unit: 1765

6. Claims 1, 3-4, and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kito et al (US 6,110,279) in view of Cook et al (US 6,352,594) and Admission.

Kito et al discloses a silicon carbide single crystal layer **15**, this reads on applicant's substrate, and forming a silicon carbide single crystal layer **19a** by a CVD method where, the temperature of silicon carbide layer **15** is increased to be 1500°C and source gases of SiH<sub>4</sub> and C<sub>3</sub>H<sub>8</sub> are introduced (col 12, ln 1 to col 13, ln 15). Kito et al also discloses a silicon carbide single crystal ingot **19** is formed on the single crystal layer **19a** by the sublimation-recrystallization method (col 13, ln 15-67), this reads on applicant's depositing SiC by the vapor phase growth method.

Kito et al does not disclose the raw material is supplied in the vicinity of the surface of the substrate and the raw material in the vicinity of the surface of the substrate is given a partial pressure higher at least by a predetermined rate than that of an impurity, thereby suppressing the impurity from reaching the surface of the substrate and preventing the surface of the substrate from being etched by the impurity.

In an improved method of CVD, note entire reference, Cook et al teaches the amount of incorporation of unwanted impurities in CVD films is proportional to the partial pressure of such impurity molecules, this is a teaching that the partial pressure is a result effective variable, and the reduction of impurities in the film produced is due to the reduced partial pressure of impurities in the gas stream above the wafers surface resulting from the increased concentration, this reads on applicant's partial pressure, of the desired reactant species in the gas stream (col 7, ln 65 to col 8, ln 67). It would have been obvious to a person of ordinary skill in the art at the

Art Unit: 1765

time of the invention to modify Kito et al with Cook et al's CVD method of reducing the partial pressure of impurities by increasing the concentration of reactants to reduce the amount of impurities in a film.

The combination of Kito et al and Cook et al teach CVD, as a method of depositing a SiC layer. The combination of Kito et al and Cook et al does not teach a surface chemical reaction between said raw material and Si or C contained in the substrate, thereby forming the thin single crystal film.

In a applicant's admitted prior art, Admission teaches a method of forming a SiC layer by a reaction between hydrocarbon and a Si substrate in a high vacuum atmosphere with remarkably low impurity concentration, note page 4, ln 1-10. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kito et al and Cook et al with Admission's method of forming SiC by a reacting a hydrocarbon with a substrate to form a SiC layer with remarkably low impurity concentration.

Referring to claim 1, the combination of Kito et al, Cook et al and Admission is silent to the raw material in the vicinity of the surface of the substrate is given a partial pressure higher at least by a predetermined rate than that of an impurity. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kito et al, Cook et al and Admission by optimizing the partial pressure rate by conducting routine experimentation of a result effective variable (MPEP 2144.05). The combination of Kito et al, Cook et al and Admission is silent to a preventing the surface of the substrate from being etched by the impurity. However, the combination of Kito et al, Cook et al and Admission teaches reducing the partial pressure of the impurities by increasing the concentration of reactants in the

Art Unit: 1765

gas streams above the wafers surface to reduce impurities, as applicant. Therefore, the etching of the substrate surface is inherently prevented because the combination of Kito et al, Cook et al and Admission teach a similar method of reduce the impurity partial pressure, as applicant.

Referring to claim 3, the combination of Kito et al, Cook et al and Admission teaches  $C_3H_8$ .

Referring to claim 4, the combination of Kito et al, Cook et al and Admission teaches  $SiH_4$ .

Referring to claim 11, the combination of Kito et al, Cook et al and Admission teaches a silicon wafer 14 (col 6, ln 35-50), this reads on applicant's Si substrate.

7. Claim 2 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kito et al (US 6,110,279) in view of Cook et al (US 6,352,594) and Admission as applied to claims 1 and 3-4 above, and further in view of Funato et al (US 5,882,807).

The combination of Kito et al, Cook et al and Admission teach all of the limitations of claim 2, as discussed previously, except the temperature elevating step from a first temperature at which etching of the surface of the substrate by the impurity is started to a second temperature not lower than a temperature at which SiC is formed.

In a method of forming Silicon Carbide by Chemical Vapor Deposition (CVD), note entire reference, Funato et al teaches heating a substrate to a temperature of 600-850°C, this reads on applicant's first temperature, and heating at a rate of 50°C/min to a temperature of 1000-1290°C, this reads on applicant's second temperature, and introducing raw material for silicon carbide (col 3, ln 40-67). Funato et al also teaches the possible raw materials are

Art Unit: 1765

methyltrichlorosilane, methyldichlorosilane or  $\text{SiCl}_4$  and  $\text{CH}_4$  (col 4, ln 1-20). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kito et al, Cook et al and Admission with Funato et al's elevating temperature at a rate of  $50^\circ\text{C}/\text{min}$  to form a SiC film without pores at a high rate without introducing cracks (col 3, ln 1-40 and col 4, ln 10-55).

Referring to claim 2, the combination of Kito et al, Cook et al, Admission and Funato et al teaches a first temperature of  $600\text{-}850^\circ\text{C}$ . The combination of Kito et al, Cook et al, Admission and Funato et al is silent to the first temperature at which etching of the surface of the substrate is started. However, this is inherent to the combination of Kito et al, Cook et al, Admission and Funato et al because the combination of Kito et al, Cook et al, Admission and Funato et al teaches a similar first temperature of  $800^\circ\text{C}$ , as applicant (note pg 15, ln 6-7). Also, the combination of Kito et al, Cook et al, Admission and Funato et al is silent to the temperature elevating rate is within a range such that the density and the size of a defect is suppressed to prevent occurrence of a planar defect. The combination of Kito et al, Cook et al, Admission and Funato et al teach a heating rate of  $50^\circ\text{C}/\text{min}$ . This heating rate is inherently within a range such that the density and size of defects is suppressed because the combination of Kito et al, Cook et al, Admission and Funato et al teaches a similar rate as applicant (note Fig 3-4 and pg 17, ln 7-9). The combination of Kito et al, Cook et al, Admission and Funato et al does not teach the partial pressure of the raw material is adjusted to a level not lower than 100 times that of the impurity. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kito et al, Cook et al, Admission and Funato et al by optimizing the



Art Unit: 1765

partial pressure by conducting routine experimentation of a result effective variable (MPEP 2144.05).

Referring to claim 5, combination of Kito et al, Cook et al, Admission and Funato et al teaches the possible raw materials are methyltrichlorosilane, methyldichlorosilane or  $\text{SiCl}_4$  and  $\text{CH}_4$  (col 4, ln 1-20).

8. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kito et al (US 6,110,279) in view of Cook et al (US 6,352,594) and Admission, as applied to claims 1 and 3-4 above, and further in view of Suzuki (US 5,985,091).

The combination of Kito et al, Cook et al and Admission teach all of the limitations of claim 5 including a silane precursor, as discussed previously, except at least one material is selected from the claimed group of materials.

In a method of chemical vapor deposition, note entire reference, Suzuki teaches a material containing Si atoms when a semiconductor thin film of SiC is formed, where silanes such as  $\text{SiH}_4$  or organic silanes such as tetramethylsilane ( $\text{Si}(\text{CH}_3)_4$ ), dimethylsilane, or tetraethylsilane can be used (col 6, ln 15-30). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kito et al, Cook et al and Admission with Suzuki's Si containing material as a source because substitution of known equivalents for the same purpose is held to be obvious. (MPEP 2144.06).

### *Conclusion*

Art Unit: 1765

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Larkin et al (US 5,709,745) teaches controlling the concentration of the crystal growing components in a growth chamber, thereby controlling impurity incorporation into the growth sites (Abstract).

Shoimi et al (US 2001/0000864) teaches a SiC deposition using a solid source Si resulting in the partial pressure of hydrogen in the atmosphere to decrease, thereby eliminating the problem of etching [0018].

Shoimi et al (EP 0933450) is equivalent to US 2001/0000864.

Hamakawa et al (US 5,021,103) teaches a hydrogen dilution rate in a mixture gas for forming Silicon carbide is equal to the partial pressure of hydrogen divided by the sum of the partial pressures of carbon containing species and silicon containing species (col 3-4).

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event,

Art Unit: 1765

however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 703-305-2667. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song  
Examiner  
Art Unit 1765

MJS

NADINE G. NORTON  
PRIMARY EXAMINER

